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Development and implementation of rural energy policies

Report of the Secretary-General

Summary

The provision of energy services to rural areas remains inadequate owing to the dispersed nature of the population and the low income levels of rural dwellers. Of the estimated 3.1 billion people in rural areas, approximately 2 billion have no access to electricity and about the same number of people rely on traditional energy sources for cooking, such as wood, charcoal and animal and plant wastes, which are associated with adverse environmental effects at the local level.

Policies aimed at providing modern energy services to rural areas in many countries have focused on extending national electricity grids to rural areas. Although these policies have been successful in many areas, they have often necessitated substantial subsidies to customers in remote areas with low population densities since the unit cost of supply is higher. These subsidies have resulted in a precarious financial position for some electricity generating companies, many of which are nationally owned. Moreover, the companies themselves often rely on national budgetary allocations for the capital cost of expanding the grid since their revenues (inclusive of subsidies) are inadequate to service finance available from private financial markets. Thus many rural areas have no access to a national grid and, even in areas which do have access, many rural dwellers are not connected. In addition, low electricity prices, along with subsidies for other conventional fuels, may have discouraged the adoption of renewable energy technologies.

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Renewable energy technologies often have cost advantages for rural areas since transportation and/or transmission costs are not a significant portion of total costs, but they may require periodic maintenance to operate efficiently. Their successful adoption in rural areas can aid in providing modern energy services with fewer adverse environmental consequences than energy services produced from conventional fuels. Recent technical advances have lowered the cost of some, and many countries are investigating the possibility of encouraging small decentralized systems to serve isolated rural areas.

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I. Introduction

1. The present report has been prepared in response to the request of the Committee on New and Renewable Sources of Energy and on Energy for Development at its second session (12-23 February 1996),[1] which was approved by the Economic and Social Council in its decision 1996/304.

2. Efforts at finding the most appropriate solution for rural area energy problems are hampered by insufficient attention to rural development in general and to rural energy needs in particular. The lack of institutional support is partly due to the fact that rural energy is a small component of the total energy used in a typical developing country and often is not even included in energy statistics and balances since much of it is non-commercial and thus not traded. With no government agency taking primary responsibility for rural energy needs, few resources have been devoted to data collection and assessment, which are important steps in developing rural energy policies, or to the promotion of suitable energy projects specifically for rural areas. Agricultural policies have often failed to recognize that the availability of adequate energy supplies can result in increased agricultural production, related increases in agro-industrial production and better market access.

II. Rural energy demand and supply

A. Demand for energy in rural areas and benefits from increasing use

3. Effective demand for energy in rural areas of many developing countries is constrained by low-income levels. Although used mainly by households for cooking purposes, energy is also used in agriculture for water pumping and irrigation. Households in rural areas are dependent on non-commercial sources of energy, such as firewood and other fuels, and their choice of fuel is often determined by energy availability in the area. Charcoal is also used in rural as well as urban areas for cooking. The production, distribution and sale of charcoal has become a small-scale industry in many rural and urban areas, which supports a large number of low-income people in developing countries.

4. As income increases, the type of energy used by rural households changes. In areas where annual per capita income is less than $300, 90 per cent of the people use traditional fuels for cooking.[2] As incomes increase above that level, to between $1,000 and $1,500 a year, households tend to rely entirely on conventional fuels.

5. Rural energy demand increases with population growth, which is slowing. Rural population in developing countries is put at 2.8 billion and average annual population growth has slowed, declining from 1.39 per cent during the period 1975-1980 to 0.86 during the period 1990-1995. Rural population growth is expected to decrease to 0.51 per cent a year during the period 2000-2005 and continue falling to 0.22 per cent during the period 2010-2015.[3]

6. Energy is used in agriculture in developing countries to pump water, irrigate crops, operate machinery and process and preserve food. Increasing energy use raises yields and improves quality. The availability of cheap dependable motors and pumps, as well as the increasing availability of fuel and/or electricity, has enabled more land to be irrigated in many countries, especially in areas unsuitable for irrigation by gravity flow techniques. In some regions, however, the proportion of irrigated land is low. In sub-Saharan Africa only 4 per cent of arable land has been irrigated; in Latin America 15 per cent is under irrigation while in Asia irrigated land is 38 per cent of total arable land. In order to provide food for a growing population, irrigated land will have to increase in the future and will result in an increased demand for energy for agricultural uses.[4]

7. As developing countries implement economic and social policies aimed at promoting rural development, commercial and light industry use of energy is expected to increase. Some rural areas may see a rise in agricultural-related industries such as food processing, while small-scale industries are likely to be a characteristic of much of the growth and development in many rural areas in which development policies are successful.

8. Increased use of energy in rural areas for cooking allows for a more varied diet. Energy available for heating improves the quality of life for rural dwellers in colder climates. Lighting in rural areas not only provides benefits to households but to heath-care clinics, where refrigeration is important, and for water pumping as well. Increased energy availability facilitates the increase of rural incomes and the reduction of poverty. Switching from the use of traditional sources of energy to modern energy sources or to renewable sources can significantly improve the health of rural dwellers. The burning of firewood and dung emits particulate matter, carbon monoxide and other pollutants which are responsible for a variety of health problems, including chronic bronchitis, emphysema and other respiratory diseases, which contribute to higher mortality rates. Infants and children are also adversely affected as acute respiratory infections, which cause approximately 4 million deaths each year, are at least partially attributable

to smoke inhalation.[5] The table shows the estimated exposure to pollutants from cooking one meal with various types of stoves.

Estimated exposure to respirable particulates (RSP), carbon monoxide (CO), nitrogen oxide (NOx) and formaldehyde (HCHO) resulting from cooking one meal on an unvented stove
(milligrams)

Type of stove	*RSP*	*CO*	*NOx*	*HCHO*
Wood fired	17.0	340.0	8.5	0.69
Kerosene	4.2	58.0	1.5	0.069
Gas	0.012	5.9	0.27	0.05

Source: E. W. Cecelski, "From Rio to Beijing – engendering the energy debate", *Energy Policy*, vol. 23, No. 6 (June 1995), p. 566.

9. The burden of gathering fuelwood from distant locations and the health consequences of burning traditional fuel fall largely on rural women, who are responsible for gathering wood and for cooking. In rural Kenya, for example, some women spend 20 to 24 hours a week collecting branches, cow dung and crop residues to use as fuel. Moreover, as men have migrated to urban areas in search of employment, additional agricultural work has been increasingly borne by women. Switching to modern fuels or to non-traditional renewable energy sources improves the quality of life for all rural dwellers, but especially for women in terms of more productive use of their time and improved health.

10. When the demand for traditional energy sources exceeds sustainable yields, forested areas shrink and brushwood and vegetation areas become seriously degraded, ultimately reducing soil fertility and, in some areas, accelerating desertification. It is estimated that 130 million people in sub-Saharan Africa live in areas where fuelwood consumption outpaces the natural regenerative capacity of the forest.[6] Even in places where the problem has not yet reached a critical level, reduced vegetation results in lower soil fertility and diminished crop yields.

11. Variations in climate and local environmental conditions cause differences in consumption patterns between regions, and even within regions, which complicates policy design. The availability of energy within an area often determines which type of traditional fuel is used. China provides an interesting example of the variations seen in rural energy demand by region. Climate conditions vary widely in different regions of the country, with climate zones ranging from temperate to subtropical with a monsoon climate. Northern areas face colder conditions in the winter. Households in rural areas consume energy for cooking, for heating, for electrical appliances (where available) and for transport. Per capita energy use in rural areas varies from 3.6 kgce (kilograms of coal equivalent) to 295.9 kgce, depending in part on geographical conditions.[7] Income variations by area and differences in economic development patterns are also factors affecting rural energy demand. Moreover, the type of energy used depends on the local availability of fuel and its cost. In some areas, small coal mines are in use and raw coal is very inexpensive or even free for miners. Electricity is not available in all rural areas but its availability affects the type of energy used. Other non-commercial energy sources, including firewood, animal wastes, bagasse, crop residues and charcoal, are also used in rural areas of China according to accessibility. While China is not typical in this regard, wide variations in the pattern and level of energy demand can be found within countries as well as within regions.

B. Supply of energy in rural areas

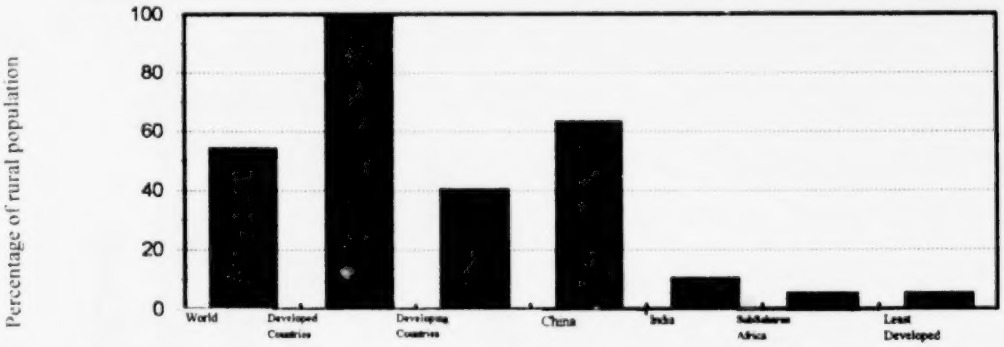
12. Energy in rural areas can be supplied from more diverse sources than in urban areas since conventional commercial sources of energy, traditional sources and a combination of renewable energy technologies may all be cost effective in rural areas, depending on the circumstances.

1. Conventional sources of energy

13. Electricity produced by hydroelectric facilities as well as from coal, oil and natural gas has become available in many rural areas as a result of rural electrification programmes undertaken in many developing countries. Petroleum is used for transport and diesel oil for producing electricity with the use of small electric generators, as well as for transport, while liquefied petroleum gas (LPG) and kerosene are often used for heating and cooking.

14. Many developing countries have made rural electrification a priority and, as a result, 820 million rural dwellers in developing countries have access to electricity.[8] Since this figure includes 500 million people who were provided access to electricity in the 20-year period from 1970 to 1990, the improvement has been considerable, although many rural dwellers still do not have access to electricity. Figure I shows the percentage of rural population with access to electricity grid services, which in some rural

Figure I. Percentage of rural population with access to electricity



Source: Based on data and estimates for 1990, in K.-N. Mak and W. Shearer, "Sustainable energy development in rural Asia", *Natural Resources Forum*, vol. 20, No. 4 (November 1996), p. 294.

Note: Recent data indicate a higher level of rural electrification in India.

areas is quite low. There is also significant variation by region, from less than 10 per cent in sub-Saharan Africa to an estimated 45 per cent in the East Asia and the Pacific region.[9] Forty per cent of rural dwellers in the Latin America and Caribbean region are connected to electricity while estimates are put at 35 per cent for North Africa and the Middle East and 25 per cent for South Asia.

2. Traditional sources of energy

15. Since traditional fuels are usually not counted in energy statistics, they are often overlooked by planners and policy makers and their supply is difficult to quantify and analyse. Thus, actual energy supply in rural areas is often higher than captured in official statistics. Regional characteristics may affect the type of traditional energy supply, but generally firewood, charcoal, biomass and animal waste are the sources of energy used in rural areas, usually by the poorest people. These sources are inefficient compared with modern fuels and often costly, whether in cash or in terms of labour time spent gathering fuel from rural areas. As shown in figure II, traditional fuels are characterized by low efficiency.

16. Firewood and charcoal are both commercially traded and non-traded sources of energy and are available in both rural and urban areas. The supply to urban areas of commercially traded firewood and charcoal has contributed to the growing shortage of fuelwood in many rural areas. Considerable environmental degradation has resulted from the overuse of wood fuels.

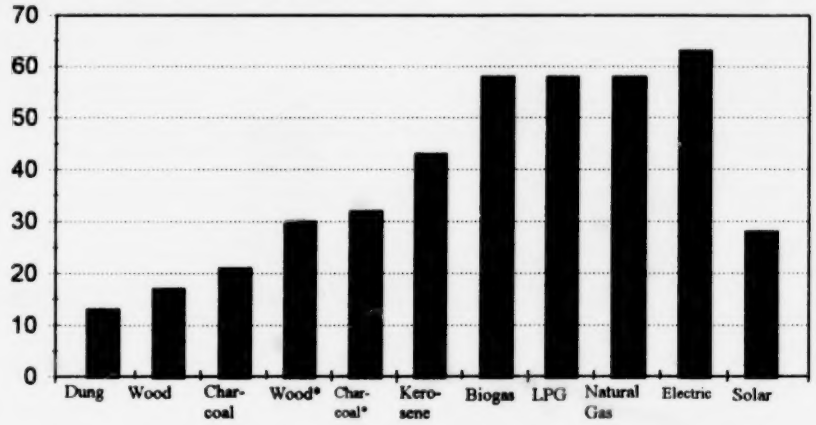
17. A number of renewable energy technologies may be cost-effective in rural areas. The decentralized systems with the most potential for rural areas are minihydropower systems, solar systems, wind energy, modern biomass, including biogas, and geothermal systems.

3. Renewable energy technologies

18. *Mini (and micro) hydroelectric*. Minihydroelectric installations generally produce less than 1 megawatt (MW) and usually do not need large expensive dams for water storage. They are cost-effective with few environmental externalities. However, their suitability depends on the topology of the area and they may not provide year-round service. Access to credit is often needed for such projects in rural areas. In addition, their construction and maintenance require technical expertise often not available in those areas.

19. *Solar systems*. Solar systems are divided into photovoltaic (PV) and solar thermal systems. PV systems convert sunlight to electricity directly. Costs are high, but they have been decreasing and this technology may be competitive in rural areas in which distance from the electricity grid makes connection prohibitively expensive.[10] Individual households have made use of PV systems together with a battery, battery-charge regulator and fluorescent lamps. Larger PV systems have proved effective in public places, markets and clinics, as well as in the provision of power for supplying water. Solar thermal systems are effective for heating water, for space heating and for drying

Figure II. Fuel efficiency of various cook stoves



Source: United States Congress, Office of Technology, *Fueling Development: Energy Technologies for Developing Countries* (OTA-E-516) (Washington, D.C., United States Government Printing House, April 1992), p. 296.

Note: An asterisk (*) denotes improved version. Data presented are midpoints of efficiency ranges.

food. They can be used in rural areas where conditions permit.

20. *Wind energy.* Wind energy is used for electricity generation and direct mechanical application. Technical advances have resulted in cost decreases in wind technologies for electricity generation during the past decade and wind power may be suitable for rural areas.[11] Wind technologies are site-limited but can compete with conventional systems in some areas. They are more prone to mechanical failure than PV systems. Wind energy is used for pumping water in many rural areas, both for irrigating farmland and for household use.

21. *Modern biomass, including biogas systems.* This refers to the thermal conversion of biomass, such as crop and wood wastes, and the anaerobic conversion of animal wastes, often in household-sized plants, to provide energy for lighting and cooking. Modern biomass is mostly gasification of biomass for use in lighting and cooking or for the generation of electricity.

22. *Geothermal systems.* Geothermal systems are generally associated with large-scale electricity grids for urban areas though they have been applied successfully in rural areas in the Philippines, Indonesia and China. Geothermal energy systems are competitive, in terms of costs, with conventional fuels for producing electricity and although adverse environmental impacts sometimes occur, they are less damaging than those associated with conventional fuels. Geothermal systems, however, are site-specific and not available in many rural areas.

23. In general, the feasibility of many of the renewable energy technologies is often site-specific, depending on local weather and climate conditions, availability of biomass and animal wastes and, in the case of minihydro projects, topography. Therefore, to promote the development of rural energy supplies, supply-oriented policies must be tailored to meet the specific conditions of each area.

4. Ensuring adequate supplies of energy in rural areas

24. Ensuring adequate energy supplies in general is a responsibility which is being increasingly shouldered by the private sector in developing countries as they undertake structural adjustment programmes calling for privatization of publicly owned industries and the elimination of costly subsidies. Energy production and distribution facilities, such as electricity generating plants and refineries, are being privatized, and subsidies to keep final prices low are being phased out in many countries. Prices of commercially traded

energy may rise as a result and may put pressure on lower cost rural energy supplies such as fuelwood and charcoal as alternative sources of energy, thereby adding to the already existing rural energy shortage in many areas.

25. In the absence of carefully defined contractual relationships between private utilities and the State, relying on the private sector to provide energy services may result in the continued neglect of the energy needs of the rural poor since potential returns on investment in rural areas may be lower than in other areas or non-existent. Appropriate policies must be designed to encourage the private sector or to encourage alternative structures such as local cooperatives to increase the provision of energy in rural areas. Kenya provides an example of successful reliance on the private sector in the solar home lighting market, which totals at least 20,000 solar electric homes, most of which are located in rural areas. Yet barriers have been identified inhibiting the expansion of the rural solar market; they relate to the lack of financing for end-users and the lack of coordinated infrastructure development.[12] For the further penetration of solar technology in rural areas, it is necessary both to train personnel to install and maintain systems, and to ensure the standardization of products and the supply of spare parts.

III. Rural energy policies and rural development

A. Rural development and energy

26. The availability of energy is a necessary condition for economic growth and can facilitate rural development. The availability of affordable energy has been credited with spurring the growth of rural areas in some developed countries following rural electrification programmes earlier this century. The fact that similar efforts in developing countries have not always resulted in economic growth supports the view that the availability of commercial energy is a necessary, but by no means sufficient, condition for rural development.

27. In an effort to achieve more balanced urban/rural growth and alleviate rural poverty, many developing countries are undertaking efforts to promote rural development as part of their overall development policies. This includes the financing of public infrastructure projects, an effort to promote more decentralized decision-making in the public sector and specific tax incentives to encourage businesses and industries to locate in less populated areas. Recognition of the importance of an integrated approach to rural development, which emphasizes the linkages between energy, agriculture and the environment, is growing.

28. Agricultural reforms often include the elimination of price controls to provide an incentive for farmers to increase output. In many developing countries markets are being liberalized as part of their accession to the World Trade Organization (WTO), and improved trade prospects for agricultural goods are expected to enhance the development prospects of rural areas by stimulating the output of agricultural goods. This implies an increase in inputs such as fertilizer and machinery, both of which may entail greater energy use.

29. Structural adjustment policies and privatization measures, while not specifically related to energy policies in rural areas, may indirectly affect energy demand and supply patterns as well as overall rural development. Previously, tariffs, exchange-rate controls and import quotas designed to protect local industries often had the effect of discouraging exports as well, because they often increased the cost of inputs. Moreover, since agricultural prices were also kept low, exports of agricultural products and other primary commodities were negatively affected. The reversal of these policies is expected to contribute to economic growth in rural areas of many developing countries.

30. Some countries, recognizing the link between rural development and energy availability, are implementing policies aimed at encouraging both in a mutually supportive fashion. China's policies, for example, aimed at both rural and urban areas include ways and means of ensuring energy supplies as economic growth occurs. China is undertaking energy projects to ensure the availability of electricity in many rural areas, including the construction of a number of hydroelectric facilities, and is encouraging the use of non-traditional energy technologies in rural and remote areas. These include biogas plants and programmes for the widespread distribution of efficient cookstoves. China has also initiated efforts at decentralizing the decision-making process to facilitate the evaluation of energy projects at the local level so that energy and developmental needs can be considered together.

31. India has initiated energy policies in line with rural development programmes, including those aimed at encouraging the use of non-traditional supplies of energy. Its Integrated Rural Energy Programme is designed to promote energy-related decisions at a decentralized level so that measures are more in line with rural development plans. It has actively encouraged the use of biogas plants, PV systems, wind technology and improved cookstoves in rural areas. Furthermore, India has the potential to develop

significant and largely untapped hydro resources for rural and urban uses

B. Financing rural energy projects

32. In the past, a number of constraints existed on the financing of rural energy projects, including the preference for centralized electricity systems, relatively low prices of conventional fuels and electricity resulting from subsidies and the paucity of loanable funds resulting from macroeconomic policies aimed at maintaining low interest rates. These factors contributed to the low investment in the energy systems of rural areas in many developing countries. In addition, rural areas may be viewed as high risk by individual investors and financial markets. Moreover, energy projects feasible in remote areas with low population densities may be too small to attract investment capital and/or funding from financial institutions. Financing may also be required for energy-saving appliances such as efficient cookstoves, which may be cost effective over a lengthy time period but which have relatively high initial purchase prices, too costly for low-income rural dwellers. Utility companies have an incentive to provide such financing and are doing so in a number of countries.

33. Some of these constraints are being eliminated gradually in countries undertaking economic reform, including the reduction and elimination of subsidies for conventional energy services and products, and the privatization of publicly owned companies, which often include electricity facilities, refineries and energy service distribution networks. However, institutional support in terms of credit arrangements and financing may still be required in rural areas, especially if Governments undertake efforts to encourage the application of renewable energy technologies. In certain instances, government-backed lending policies as well as support of microcredit schemes and other innovative lending arrangements may be justified.

34. Community-based financing of small units designed to serve small dispersed communities in remote areas may be most appropriate especially when income levels are very low. Renewable energy technologies such as minihydro facilities, PV systems and wind power, which may be competitive but which have relatively high start-up costs, could become the system of choice with the availability of financing. Cooperative arrangements in which the community is involved in the decision-making process have been successful in some countries in providing electricity services.

35. India has been providing support to wind and other renewable energy projects for the past decade. Financing with attractive interest rates to developers of up to 75 per cent of renewable energy projects, tax breaks and financial incentives for provincial electricity boards have helped increase total installed capacity of renewable energy from 200 MW in early 1995 to almost 850 MW. India expects the private market to continue financing such projects as it gradually withdraws government support.

36. The Grameen Bank of Bangladesh has initiated a programme to provide credit for renewable systems to serve those without access to electricity, through a non-profit rural energy company established in 1996. Loans are made for solar home systems using photovoltaic systems with small down payments. It expects that 100,000 PV systems will be operating in rural area homes by the year 2000. The bank plans to expand this service by offering small loans for wind power and biogas plants, and demonstration projects are currently under way to determine the most appropriate financing package.

37. Community-based financing of small-scale grids in rural areas has been facilitated by the participation of non-governmental organizations in some countries. In Peru and Nepal, for example, non-governmental organizations have provided credit for small grids powered by minihydro systems. Moreover, demonstration projects have made use of microfinancing for renewable energy technologies such as PV stand-alone systems and biogas plants, in some cases.

38. In addition, a number of international organizations are currently looking further into ways to finance renewable energy technologies mainly aimed at providing electricity services to rural areas. International organizations as well as bilateral aid arrangements have also provided funding for comprehensive energy programmes as well as individual demonstration projects for applications of renewable energy technologies in most regions of the world. Some of the government-supported programmes, for example those in China, India and Argentina, receive partial funding from the World Bank and other funders. However, these types of activities could be expanded at the national, regional and international levels. An innovative financing programme was recently established as a private fund with government guarantees in Eastern Europe to provide financing for PV systems and delivery channels, which could spur PV sales in rural areas from 10-20 MW annually to 100-200 MW annually in five years, without the need for costly subsidies.

39. The Conference of African Ministers responsible for the Development and Utilization of Mineral Resources and Energy recently recommended that revenues from electricity

tariffs and taxes on petroleum products be used for financing rural electrification in Africa.

C. Rural energy development and the local environment

40. Issues related to the environmental impact of the development and use of energy in rural areas have not received the attention they deserve and information about the impact of such policies, when they have been undertaken, is scarce. An exception is Kenya, which has undertaken a number of initiatives designed to promote better management of all resources at the community level in rural areas. To combat deforestation, the Kenya Energy and Environment Non-Government Organization has programmes to disseminate information about efficient wood-burning stoves and for the promotion of reforestation. The Participatory Rural Appraisal programme encourages community development for resource management at the village level.

IV. Rural energy policies as part of national energy policies

A. Pricing policies

41. Many countries have implemented measures to maintain below market prices for energy products and services, including those commonly used in rural areas. Electricity is often subsidized, as are kerosene, LPG and diesel fuel. Although intended as a benefit for low-income groups as a way of providing for basic needs, and as a means of encouraging economic development, these measures, in the long term, have in many cases led to greater-than-optimal levels of consumption and have contributed to fiscally untenable positions of electricity facilities and refineries, often government-owned and operated, as revenues have not been enough to cover costs. The quality of service has suffered as a result of subsidized pricing policies. In some countries, such policies have resulted in the overuse of related products, such as pumped water. Partly to rectify these problems and partly to encourage private-sector involvement in the energy service industries, many countries have begun to reduce subsidies, usually at a graduated pace.

42. Subsidies have also been criticized for benefiting higher income classes more than the poorest segment of society. This is especially relevant in rural areas since, as noted earlier, the poor often do not purchase energy services in the market, but gather their own fuel.

43. Price subsidies on electricity and the extension of the national grid in many countries has also been attributed to influencing the choice of energy services where non-traditional energy supplies may be more efficient. Price subsidies have been necessary in connecting many rural areas to a national electricity grid since connection costs are often too high to be passed on to rural consumers. In some cases lifeline pricing and cross-subsidization may be justified. With lifeline pricing, a low price is charged to those utilizing minimal levels of electricity. As incomes increase, electricity use grows and higher prices are charged for incremental amounts used. Higher unit prices on the greater amounts used cover the costs of subsidization. This is effective in areas where development is occurring and incomes are growing. With cross-subsidization, higher-income users are charged a higher rate to cover costs of lower-income users, who are charged below-cost prices. These pricing schemes have the advantage of providing electricity to the poor without negatively affecting the financial solvency of the electricity company. However, the gradual reduction of subsidies is expected to positively affect the prospects of alternatives to the national grid in remote areas with low population densities. PV lighting systems, minihydro systems and other renewable energy technologies may be better able to compete with electricity supplied from the national grid in the absence of price subsidies.

B. Incentives for developing national energy resources

44. Rural areas often face unique obstacles which discourage private sector initiatives in developing energy sources. In remote areas that are difficult to reach, it may be costly to transport fuels and provide energy services. Low population densities may render average cost pricing for such services prohibitively expensive for typically poor rural dwellers. Some incentives may be required to encourage the development of national energy sources in rural areas. These incentives have constituted a significant part of rural energy policies in many developing countries and have ranged from rural electrification programmes to the distribution of more efficient cookstoves and the promotion of biogas plants in rural areas.

45. Rural electrification programmes have typically concentrated on connecting rural villages and remote areas to a national grid often owned and operated by the

Government. Thailand is considered a success story as its rural electrification programme, which began in 1974, has increased the proportion of electrified villages from 20 per cent to 98 per cent. The success of the programme is credited to careful expansion planning, efficient billing, a cross-subsidizing rate structure designed to charge large users higher amounts than small users, responsiveness to customers and marketing programmes.

46. Kenya's Rural Electrification Programme provides incentives to consumers to connect to the electricity grid where available. Under this programme, the consumer is required to pay only a token connection fee ($40) and a small meter charge ($5) compared with actual connection costs, estimated to be at least $1,640. Connections have been averaging 5,000 per year during the 1990s, but the programme is hampered by lack of funds. Only 3.4 per cent of the electricity supplied by the national grid reaches rural customers.

47. Argentina has recently begun implementing an innovative rural energy plan designed to encourage private-sector involvement in providing rural energy services to four provinces initially. In each province private companies bid for the right to provide electricity services to the previously unserved population, expected to total 1.4 million people and 6,000 public buildings. Electricity may be provided by any energy source but officials expect that most will utilize renewable energy sources and that 80 per cent of the electricity will by provided through PV home systems. Fifty per cent of costs will be covered by tariffs, 30 per cent by provincial funds and 20 per cent will be provided by the federal Government with assistance from the World Bank. Total investment in the four provinces is expected to be $300 million and cross-subsidies between the grid and rural customers will not be allowed. This programme holds promise for rural electrification throughout the country and eventually all rural provinces will participate.

48. China's energy programme includes specific energy policies aimed at rural areas ranging from the development of local resources such as minihydrosystems to the distribution of efficient cookstoves. As a result of its ambitious cookstove programme, over half of China's farmers have efficient cookstoves, and fuelwood savings are estimated at between 25 per cent and 33 per cent. China has also actively encouraged the use of biogas plants and there are now 5 million family-sized biogas plants in use in rural areas throughout the country. Minihydropower is also utilized in areas where water resources are suitable and there are now more than 60,000 units with total installed capacity of more than 17 GW. Though conventional energy development and distribution are still largely controlled by the central Government, China has made efforts to decentralize rural energy decision-making and, as noted above, is also incorporating specific energy measures in overall developing planning, with a view to promoting sustainable development.

49. Policies aimed at improving rural energy systems in India have been undertaken under the auspices of the Ministry of Nonconventional Energy Sources and have included the National Project on Biogas Development and the National Programme on Improved Chulhas (cookstoves). These programmes are expected to benefit between 10 per cent and 15 per cent of total rural households in India by the end of the century and focus on increasing energy efficiency through better technology. In addition, India has a programme to encourage PV systems using national manufacturing capabilities financed by national funds as well as the Global Environment Facility.

50. Policies designed to encourage sustainable forestry consumption and production patterns and the efficient management of forest resources may also have a positive impact on energy supplies in rural areas. Some countries, including Burkina Faso, Niger, India and the Republic of Korea, have placed forest resources under the management of local authorities to ensure policies best suited to local needs.

C. Environmental policies

51. A major obstacle in the adoption and implementation of environmental policies specifically aimed at avoiding or reducing environmental impacts associated with energy use, is the problem of harmonizing environmental and energy policies at the national level.

52. Environmental regulations in many developing countries are undertaken mainly to solve localized pollution problems typically resulting from urbanization and industrialization. Measures directed towards rural areas in some countries are aimed at preserving forest areas by prohibiting firewood collection but these are often ignored by local rural dwellers. Enforcement is difficult without the cooperation of local residents. Policies undertaken in some countries to combine firewood collection regulations with agro-forestry and afforestation programmes may be more effective since they may offer local residents a viable alternative to firewood collection.

V. Conclusions and recommendations

A. Rural energy policies and rural development

53. Policies for rural development and those aimed at enhancing rural energy services should be developed and implemented in a mutually reinforcing way:

(a) Developing countries should include rural energy as part of overall rural development strategies. To this end, appropriate government agencies within the ministry responsible for national energy policy should be assigned specific responsibility for rural energy. In some cases the most appropriate agency may be at the provincial or local level;

(b) Further efforts at the local, national and international levels should be undertaken to provide quantitative and qualitative information on the availability and use of energy from all sources in rural areas for use by policy makers;

(c) Rural development policies should be initiated and/or strengthened. In this context the bias towards urban development in the policies of many developing countries should be eliminated and, *inter alia*, macroeconomic policies adopted at the national level should not favour urban areas at the expense of rural areas;

(d) The provision of electricity to unserved rural populations should be a priority, undertaken on the basis of programmes for specific regions over periods of 5 to 10 years;

(e) For rural areas not connected to grids, sustained programmes of investment in decentralized rural energy schemes, based on renewable energy, where reasonable, should be launched, with the incremental cost of such schemes to be met, where necessary, from global sources such as the Global Environment Facility;

(f) Changes in the energy-service mix demanded by rural dwellers should be monitored for environmental impacts in order to adjust environmental policies in a timely fashion.

B. Energy pricing in rural areas

54. In rural areas, as elsewhere, rational pricing of energy is necessary to encourage conservation and efficient use. The principle instruments for correcting energy prices in rural areas are the removal of subsidies and/or poorly designed price controls. Governments should seek to implement such changes while reducing their possibly negative effects in three ways:

(a) Implementation of differential pricing for electricity, by establishing low or "lifeline" tariffs to poor households and very much higher tariffs to wealthier consumers, such that the average price for the sector reflects the full marginal costs of supply;

(b) The elimination of politically motivated price controls, shifting the responsibility for determining and monitoring price guidelines to independent regulatory authorities, with consumer representation and acting within the framework of transparent rules;

(c) Increasing prices gradually so that consumers develop an in-built expectation that energy prices will rise through time, enabling consumers to plan to adjust their consumption.

C. Meeting the costs of financing energy supply

55. An increasing number of countries are relying on the private sector for the provision of energy services, which becomes possible in the context of pricing reform. While this trend has positive ramifications, particularly for the efficient use of resources, there may not be enough incentives for the private sector to provide energy services to low-income, low-density rural areas:

(a) At the national level, there is need for innovative financing arrangements in rural areas, especially for low-income rural dwellers. Microfinancing arrangements with initial grants from the Government may be appropriate in some areas. Cooperative arrangements for the supply of certain energy services may be facilitated with credit arrangements as well. Incentives in the form of licensing agreements may encourage the private sector to provide certain energy services in rural areas;

(b) At the regional and international levels, aid programmes for the development of rural energy services should also be designed to support private-sector involvement in rural areas. Technical assistance in establishing and operating microcredit schemes specifically for the provision of energy services in rural areas may be among important activities appropriate for such programmes in many countries.

D. Improving the enabling environment for renewable energy

56. Renewable energy technologies hold promise for providing energy services to some remote rural areas owing to recent technical advances which have resulted in lower costs, rendering such technologies competitive in some rural areas:

(a) At the national level, there is a need to raise awareness and educate consumers about the advantages and disadvantages of renewable energy technologies most suitable for rural areas. Existing extension programmes may be utilized for such activities in some areas while, in other areas, extension programmes should be established and/or strengthened to undertake this type of activity;

(b) Programmes and projects to disseminate information and provide training about successful programmes in other regions may be suitable for funding by regional and international organizations;

(c) Programmes should be established to provide institutional support for renewable energy systems by encouraging and facilitating distribution systems;

(d) At the national level, there is a need for technical training programmes to enable the periodic maintenance required for the efficient operation of many renewable systems as their use spreads.

Notes

[1] *Official Records of the Economic and Social Council, 1996, Supplement No. 4* (E/1996/24), chap. I, sect. B, draft decision II.

[2] D. F. Barnes, R. van der Plas and W. Floor, "Tackling the rural energy problem in developing countries", *Finance and Development*, vol. 34, No. 2 (June 1997), p. 12.

[3] *World Urbanization Prospects: The 1996 Revision* (forthcoming United Nations publication).

[4] United Nations Development Programme, *Energy After Rio: Prospects and Challenges* (New York, 1997), p. 28; and Food and Agriculture Organization of the United Nations, *Agriculture: Towards 2010* (Rome, 1995).

[5] World Bank, *Rural Energy and Development* (Washington, D.C., 1996) p. 21.

[6] Food and Agriculture Organization of the United Nations, *Energy for Sustainable Development and Food Security in Africa* (Rome, 1996).

[7] J. W. Sun, "Real rural residential energy consumption in China, 1990", *Energy Policy*, vol. 24, No. 9 (1996), p. 829, based on official 1990 statistics.

[8] World Bank, *Rural Energy and Development* ..., p. 42.

[9] D. F. Barnes, R. van der Plas and W. Floor, loc. cit., p. 12.

[10] See *Proceedings of a Seminar on Sustainable Development of Rural Areas: Decentralized Electrification*, Marrakesh, 13-17 November 1995.

[11] See the report of the Secretary-General on renewable sources of energy, with special emphasis on wind energy (E/C.13/1998/4).

[12] M. Hankins, "Limits of the market approach for the PV rural electrification in Kenya", in *Proceedings of a Seminar on Sustainable Development of Rural Areas: Decentralized Electrification*, Marrakesh, 13-17 November 1995, pp. 97-103.